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REPORT NO. 11

MILITARY SPACE PROJECTS

JUNE - JULY - AUGUST 1960

OFFICE OF THE DIRECTOR
OF
DEFENSE RESEARCH AND ENGINEERING

Approved John H. Rubel

John H. Rubel,
Acting Director

DEPARTMENT OF DEFENSE WASHINGTON 25, D.C.

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DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING
WASHINGTON 25, D. C.

October 20, 1960

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: Progress Report on Military Space Projects for June, July, and August 1960

Progress of the Military Space Projects during June, July, and August 1960 is reviewed in the attached summary.

Noteworthy events occurring subsequently to date are summarized in your letter of transmittal to the President, which I recommend that you sign.

John H. Rubel

JOHN H. RUBEL
Acting

Inclosure - 1
Ltr to President
w/summary report

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THE SECRETARY OF DEFENSE
WASHINGTON

October 24, 1960

Dear Mr. President:

A summary of progress on the Military Space Projects during June, July, and August 1960 is attached.

A brief review of some events of interest that have occurred subsequently is included in this letter.

DISCOVERER XV was launched from Vandenberg Air Force Base and successfully placed into orbit on 13 September 1960. On the 17th pass, the capsule was separated but, because of an abnormally fast consumption of control gas, the capsule landed in the water some 900 miles south of the intended impact point. Recovery was prevented by a storm. Launch of DISCOVERER XVI is planned during the last week in October 1960.

[redacted]

The TRANSIT 2A navigation satellite, launched into orbit 22 June is performing well. All satellite and ground station systems are performing satisfactorily.

COURIER 1B was launched successfully into a satisfactory near-circular orbit of approximately 635 nautical miles altitude on 4 October 1960. This is the first active delayed repeater communications satellite to be placed into orbit for research and development purposes. All functions of instrumentation are operating satisfactorily.

With great respect, I am

Faithfully yours,

(Signed) Thomas S. Gates

Attachment

The President

The White House

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SUMMARY

June, July, August 1960

DISCOVERER PROJECT (Research and Development Satellites)

DISCOVERER XIII and XIV were launched into polar orbits on the 10th and 18th of August, respectively. After orbiting the earth for over 26 hours both capsules were recovered. DISCOVERER XIII was recovered from the sea and DISCOVERER XIV was snatched from the air by an Air Force C-119. These events marked the first time in history man-made objects which had been in orbit around the earth were returned and recovered.

Extensive recovery system component system drop tests were conducted at Holloman Air Force Base, New Mexico. The capsules containing diagnostic payloads were carried by balloons to 100,000 feet altitude and released. They then went through a normal ejection sequence while the payload transmitted valuable data to the ground station. A full-scale mockup of a biomedical capsule designed to maintain a chimpanzee in orbit for two days was completed in June.

Van type telemetry readout and recording equipment has been installed on Christmas Island to monitor all orbital passes within range of the station and record all telemetry data during re-entry.

[redacted]

MIDAS PROJECT (Very Early Warning Satellites)

In July, the Air Force Ballistic Missile Committee authorized two MIDAS flights using THOR/AGENA "B" vehicles from the DISCOVERER Program. These flights will carry a background radiometer rather than an infrared missile detection payload. The vehicles are scheduled to be launched in November and December.

Assembly of the AGENA "B" vehicle for the third MIDAS flight is proceeding on schedule. This will be the first MIDAS vehicle to utilize the full dual-burn capability of the AGENA engine. A definitive contract for the advanced infrared detection payload is being developed by Aerojet-General.

A government-to-government agreement is being drafted for the United Kingdom readout station in anticipation of approval of the MIDAS operational program. Authorization has been granted to proceed with the establishment of the Southeast Africa station. Construction of the Donnelly Flats, Alaska, technical facilities is proceeding on schedule.

TRANSIT PROJECT (Navigation Satellites)

TRANSIT 2A satellite was successfully launched into orbit about the earth on 22 June 1960 by a THOR-ABLE STAR launching vehicle at Cape Canaveral, Florida. Telemetered and tracking data received indicate that all components of the satellite are functioning normally.

TRANSIT 2A carried pick-a-back fashion an auxiliary satellite, GREB to determine effects of the ionosphere in a study of solar radiation. Separation of the satellite successfully occurred at time of injection into orbit.

From the tracking data of TRANSIT 2A, excellent orbits have been determined and studies of geodetic problems are continuing with favorable results.

Analysis of the excellent data received from the TRANSIT 1B satellite, which was launched 13 April 1960, is being made in developing procedures for predicting accurate orbits for 30 to 90 days ahead. Also with the TRANSIT 1B data, active investigation of the gravitational field of the earth and geodetic studies are being pursued.

Detailed design of TRANSIT 3A is virtually complete, and fabrication of the satellite is in progress.

NOTUS PROJECT (Communications Satellite)

The two launchings for COURIER, the delayed repeater satellite, originally scheduled for 19 July and 1 September 1960 were rescheduled for 16 August and 4 October because of needed modifications in the second stage of the THOR-ABLE STAR launch vehicle. The launching of COURIER 1A on 18 August was unsuccessful. (COURIER 1B was launched successfully into a satisfactory near-circular orbit of approximately 635 nautical miles altitude on 4 October. This is the first active delayed repeater communications satellite to be placed into orbit for research and development purposes. All functions of instrumentation have been tested and are operating perfectly).

The technical scope of the ADVENT Project, was defined as a 5-year research and development program. Ten launches are programmed from the Atlantic Missile Range. Contracts for ground station, tracking, and microwave communications equipment have been awarded.

On 15 September, the over-all technical and management responsibility for the COURIER and ADVENT Projects was transferred from the Advanced Research Projects Agency to the Department of the Army.

SHEPHERD PROJECT (Tracking Network)

Work continued on improvements in the space surveillance (SPASUR) system. A contract for the 500-kw control transmitter is in negotiation. Proposals for associated transmitter antenna are being evaluated. Work continued on the automatic digital data processing and alert system for all receiving stations. Completion of this work is scheduled for the spring of 1961.

A conceptual design plan for a permanent National Space Surveillance Control Center is being evaluated. This plan completes the research effort for the SPACETRACK Project.

The two 40-foot tracking antennas under development were considered to be of greater use for intelligence purposes than for space programs and were transferred from the SHEPHERD Project.

I. DISCOVERER PROJECT

(RESEARCH AND DEVELOPMENT SATELLITES)

A. Project Objectives

Objective is to develop and test components for Military Space Technology Program.

The objectives of the DISCOVERER Satellite Project are to conduct research and development on components, equipment, instrumentation, propulsion, data processing, communications, capsule recovery and operating techniques all dealing with military space technology.

B. Project Description

DISCOVERER Project consists of the launch of 37 satellite vehicles.

The DISCOVERER Program consists of the design, development and flight testing of 37 two-stage vehicles, using the THOR IRBM as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Projects Agency, with technical management assigned to Air Force Bassistic Missile Division. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

C. Progress Review - June, July, August 1960

1. Flights

a. DISCOVERER XII

DISCOVERER XII was launched on 29 June from Pad 4 at Vandenberg Air Force Base. The satellite vehicle failed to attain orbit.

(1) DISCOVERER XII was launched on 29 June from Pad 4 of Complex 75-3, Vandenberg Air Force Base. The countdown proceeded satisfactorily with minor technical holds because of ground support equipment problems. The major hold was caused by weather. The launch, first stage trajectory, engine cutoff, and separation were normal.

AGENA engine ignition, thrust and engine cutoff were also normal. However, the satellite failed to achieve orbit. Telemetry data indicate that the AGENA vehicle was in a pitch down attitude during engine operation causing the vehicle to re-enter the atmosphere. Subsequent investigation has isolated the cause of the improper pitch attitude to the horizon scanner.

RF interference from the satellite telemetry transmitter caused improper operation of the horizon scanner on the DISCOVERER XII flight.

(2) The cause of improper horizon scanner operation during the DISCOVERER XII flight was found to be RF interference from the satellite telemetry transmitter. A modification was incorporated to correct this condition. Subsequent testing revealed no RF interference with the scanner at any frequency or transmitter power level.

DISCOVERER XIII launched into polar orbit on 10 August. Performance of THOR booster and AGENA vehicle was very satisfactory.

b. DISCOVERER XIII

(1) DISCOVERER XIII was launched from Vandenberg Air Force Base on 10 August and was successfully injected into polar orbit. THOR booster trajectory was slightly high and west but was well within tolerance. Second stage separation was successfully accomplished as was transmission of Commands 5 (time-to-fire correction) and 6 (velocity-to-be-gained correction). AGENA performance was very close to nominal. Re-orientation of the satellite into a nose aft attitude was accomplished after burnout. Table 1 lists nominal and actual orbital parameters.

TABLE 1. DISCOVERER XIII Orbital Parameters

PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	408	429
Perigee, Statute Miles	140	155
Eccentricity	0.0323	0.0326
Period, Minimum	93.5	94.1
Inclination Angle, Degree	81.69	82.67
Injection Altitude, Statute Miles	140	156
Injection Angle, Minimum	0	+0.08
Injection Velocity, ft/sec		25,852

The recovery sequence was initiated, the capsule survived re-entry, and the parachute deployed successfully.

(2) The recovery sequence was automatically initiated by the satellite programmer 26 hours, 37 minutes after launch. This event occurred within range of the Kodiak, Alaska tracking station as DISCOVERER XIII passed southward toward Hawaii on its 17th orbit. Telemetry received by Kodiak from the satellite and the capsule confirmed that satellite pitch-down, capsule ejection, spin, retro rocket firing, capsule despin and thrust cone ejection were accomplished. Minutes later the Hawaiian tracking station acquired the telemetry signal and determined that ablative shield ejection and parachute deployment had occurred.

Aircraft could not attempt recovery. Capsule rescued from sea by frogman from recovery ship helicopter.

(3) All aircraft and ships of the recovery force within range acquired the capsule's RF beacon and began homing on the signal. No aircraft was able to attempt recovery, but one plane did observe the capsule impacting in the sea. A helicopter from the "Haiti Victory", one of the recovery ships, was sent to retrieve the capsule. The capsule was flown to Hawaii by helicopter, transferred to an Air Force plane, and delivered to Washington, D. C. After being viewed by President Eisenhower, the capsule was placed on public display by the Air Force. This historic object, the first man-made object recovered after a sustained period of orbit, will become part of the Smithsonian Institute's collection of space vehicles.

DISCOVERER XIII carried a diagnostic payload which transmitted data about capsule environment and recovery sequence events.

(4) DISCOVERER XIII carried a diagnostic payload in addition to the normal recovery equipment. The payload contained instrumentation to determine capsule environment and the functioning of separation and recovery sequence events. A five channel telemetry system was installed to transmit the data obtained to the ground stations. To assure receipt of all data, a tape recorder was provided to record the real time events and capsule performance during the telemetry "blackout" period which occurs when the capsule reenters the atmosphere. After a two-minute time delay, these stored data were transmitted to the ground stations. The high speed of re-entry induces ionization over the skin of the capsule which effectively blocks telemetry transmission. An S-band transponder was also provided to aid in tracking the capsule from ejection through recovery.

DISCOVERER XIV was delayed on 18 August because the DISCOVERER XIII vehicle was passing through the projected flight area.

c. DISCOVERER XIV

(1) DISCOVERER XIV was launched on 18 August into a polar orbit from Vandenberg Air Force Base. The launch was delayed approximately 15 minutes because the still orbiting DISCOVERER XIII satellite was passing through the projected flight area. THOR booster performance was near nominal. Separation, transmission of Commands 5 and 6, and orbital boost were accomplished as planned. Nominal and actual orbital parameters are given in Table II.

TABLE II. DISCOVERER XIV Orbital Parameters

PARAMETER	NOMINAL	ACTUAL
Apogee, Statute Miles	428	500
Perigee, Statute Miles	118	111
Eccentricity	0.037	0.046
Period, Minimum	93.4	94.5
Inclination Angle, Degree	79.6	79.6
Injection, Altitude Statute Miles	118	118
Injection Angle, Minimum	0	-0.22
Injection Velocity, ft/sec		26,150

AGENA vehicle was in an abnormal attitude during its first orbit but stabilized on subsequent passes.

(2) On the first pass over Kodiak, telemetry data indicated an abnormal satellite attitude, stop indications by the horizon scanner and excessive control gas consumption. The satellite stabilized in its proper attitude on subsequent passes and orbited as planned.

The capsule was ejected on the 17th orbit. The crew of a C-119 sighted the capsule and on their third pass snagged the parachute and safely reeled the capsule aboard.

(3) While on its 17th orbit the satellite programmer automatically initiated the recovery sequence. The capsule re-entered the atmosphere and its parachute was deployed. A C-119, one of the airborne recovery force, homed on the CW beacon signal and visually sighted the capsule. On the third pass, the hooks on the special air-recovery gear snagged the nylon canopy. The chute and capsule were carefully reeled in and were safely aboard the aircraft. The capsule is presently being analyzed at the contractor's facility.

2. Technical Status

a. Second Stage Vehicles

One of the two remaining AGENA "A" vehicles is ready for launch.

(1) Only two DISCOVERER AGENA "A" vehicles remain to be flown. DISCOVERER XV is now at Vandenberg Air Force Base in preparation for a September launch. The remaining vehicle is at Sunnyvale for modifications incorporating the improvements from the latest flight tests.

Three AGENA "B" vehicles have been accepted by the Air Force; two of these have been delivered to Vandenberg Air Force Base.

(2) Two AGENA "B" satellites were delivered to Vandenberg Air Force Base during August and are currently undergoing subsystem checks in the missile assembly building. An additional AGENA "B" has been accepted by the Air Force and is awaiting shipment to Vandenberg. Three vehicles have completed their test firings at Santa Cruz Test Base and are being readied for Air Force acceptance inspections.

XIR-81Ba-9 engine nozzle coating and modified fuel injector tests continue.

(3) Evaluation and testing of nozzle coatings in an effort to reduce XIR-81Ba-9 engine throat erosion continued during June. The test results using a modified fuel injector have been encouraging. Tests of this injector will continue.

An XIR-81Ba-9 engine start and restart firing series was completed in June.

(4) Testing of the XIR-81 Ba-9 engine (with 45:1 area ratio nozzle) continued at Arnold Engineering Development Center. An engine start and restart firing series, with the engine mounted in a modified test stand to permit gimballing, was completed in June. This series covered operation in a temperature range of from 120 to -55 degrees F.

Phase two of the Preliminary Flight Rating Tests was initiated during August.

(5) Phase two of the Preliminary Flight Rating Tests on the XIR-81 Ba-9 engine (serial number 306) was initiated during August. After being retrofitted with flight configuration components, the engine was installed on the Bell Test Center vertical test stand for initiation of start-stop and malfunction tests. A 30-second restart firing was accomplished, but test data indicated a 2.75 percent shift in the power level. The engine was torn down for examination. Tests of this engine are expected to resume early in September.

First flight configuration XLR-81 Ba-9 engine completes acceptance testing.

(6) The first XLR-81 Ba-9 engine (serial number 316) delivered with flight configuration hardware, has successfully completed acceptance testing. One engine (serial number 317) has been hot fired but operation was unstable and the power level dropped. Analysis disclosed that the gas generator venturis required re-sizing and that the oxidizer filter was improperly installed. This engine is now being prepared for final acceptance testing.

"Cold-gas" spin/de-spin system incorporated into DISCOVERER payloads.

b. Recovery System Component Test Program.

(1) Extensive examination of the results of DISCOVERER flights I through XI indicated the possibility of tumbling and/or precession of the capsule upon separation from the AGENA vehicle because one or more of the spin/de-spin rockets failed to fire properly. To correct this condition, a "cold gas" spin/de-spin system has been incorporated into the DISCOVERER payloads. The "cold gas" system contains two separate subsystems each supplying a maximum of 195 pounds thrust, with a firing duration of 0.8 seconds. Each system contains a gas sphere (containing a nitrogen and freon gas mixture), a manifold, a squib operated valve, and exhaust jets.

Drop tests of the parachute and retrofiring systems have been conducted at Holloman Air Force Base.

(2) Drop tests of DISCOVERER capsules continued throughout the quarter at Holloman Air Force Base, New Mexico. Originally scheduled for nine drops, the test series was extended to permit testing of the capsule parachute system and the retrofiring system. "Cold gas" system tests were initiated on 23 June. The third and fourth successful balloon drops of the recovery system series (second and third successful dynamic tests of the "cold gas" spin system) were made at Holloman Air Force Base on 23 and 27 July. The retro rocket and spin/de-spin systems functioned satisfactorily. During the tests, chaff was dispensed from the pilot chute deployment bag and did not contact the main chute, indicating that the prior interference problem has been solved.

Capsule is carried to 100,000 feet altitude, released upon ground command, and proceeds thru the normal recovery sequence.

(3) For each of the drop tests, the capsule is carried to 100,000 feet altitude. On command from the ground, the capsule is released. During the retrofiring system drop, the ejection programmer within the capsule fires the spin system, the retro rocket, and the de-spin system in the normal ejection sequence. Parachute deployment is also controlled by the ejection programmer. These capsules are fully instrumented to monitor capsule performance and contain telemetry equipment to transmit the data obtained. In the parachute deployment test, the Mach and dynamic loading conditions encountered in actual recoveries are experienced.

Mark IV capsule drop tests conducted in August.

(4) The drop test programs continued at Holloman Air Force Base with two test attempts on 4 August. The first balloon burst at 30,000 feet, before the planned drop of the Mark IV capsule; however, the equipment was recovered successfully. On the second, the capsule was dropped and parachute deployment was satisfactory. The purpose of these tests was to determine if the new parachute cover would release properly during capsule deceleration. The Mark IV capsule is similar to the recently recovered capsules but contains an improved programmer and other modified components.

c. Biomedical Capsules

A full-scale mockup was prepared as part of the Advanced Biomedical Capsule Study.

The Advanced Biomedical Capsule Study was completed on 17 June. This study indicated the feasibility of developing a capsule capable of maintaining a chimpanzee in orbit for two days. The capsule would be integrated with the SAMOS recovery vehicle. A final report, preliminary drawings and a full-scale mockup have been prepared as part of the study.

3. Facilities

Telemetry readout and recording equipment has been installed on Christmas Island. An additional ship and five telemetry equipped aircraft supported the recent DISCOVERER flights.

a. In June, a van type telemetry readout and recording installation was established on Christmas Island to provide monitoring and recording facilities downrange from Hawaii. The equipment at this station monitored all orbital passes within the range of the station and recorded all telemetry from the diagnostic payload and from the AGENA vehicle. During the recovery pass, this installation extended the telemetry reception on

coverage south of the equator. For DISCOVERER XIII and XIV flights an additional ship and five telemetry equipped aircraft were dispersed between Hawaii and Christmas Island to increase telemetry coverage south of Hawaii.

Vandenberg Air Force Base data acquisition and processing building air conditioning modification completed.

b. Acceptance of the air conditioning system modification for the Vandenberg Air Force Base data acquisition and processing building was made in August following successful completion of an equipment test run.

SAMOS

Pages 9 through 15 are entirely exempt from declassification.

E.O. 12065, Sec. 1-301 (a)
Defense letter 10/19/79
NLE Date -- 10/29/79

MIDAS

III. MIDAS PROJECT

(VERY EARLY WARNING SATELITE)

A. Project Objective

MIDAS will provide early warning of ballistic missile attack.

The MIDAS project (Missile Defense Alarm System) is aimed toward establishing a series of satellites around the earth in polar orbits. These will carry payloads consisting of infrared detection scanners capable of detecting emanations from ballistic missiles being launched, as the missiles rise above the atmosphere.

B. Project Description

MIDAS provides infrared reconnaissance against enemy ICBM attack.

1. The MIDAS system is designed to provide continuous infrared reconnaissance of the Soviet Union and a satellite-borne ICBM attack alarm system for the United States. In the operational system, surveillance will be conducted by eight satellite vehicles in accurately positioned orbits.

How MIDAS operates.

2. The area under surveillance must be in line-of-sight view of the scanning satellite. Infrared radiation sensors capable of detecting the infrared energy emanating from the rocket plume would provide information on the number of missiles launched, the approximate launch location, and the approximate direction of flight of the missiles. The system will see only those sources of radiation which rise above the greater portion of the atmosphere. Each such sighting will be instantaneously communicated to at least one of three MIDAS readout stations strategically located in the United Kingdom, Greenland, and Alaska. These stations will be co-located with the Ballistic Missile Early Warning System (BMEWS) stations to the extent possible and will complement the BMEWS system. Data will be transmitted directly to the MIDAS Control Center where the information is processed, displayed and evaluated. If an attack is determined to be under way, the intelligence is communicated to a central Department of Defense Command Post for relay to the President for decision to counter attack and then for relay to all national retaliatory, and defense agencies.

C. Progress Review - June, July, August 1960

1. Flights

The Air Force Ballistic Missile Committee has authorized two additional MIDAS flights. A background radiometer will be carried by THOR/AGENA "B" vehicles currently in the DISCOVERER Program.

a. In July, the Air Force Ballistic Missile Committee authorized two additional MIDAS flights, designated RM-1 and RM-2, to be conducted using THOR-boosted AGENA "B" vehicles currently in the DISCOVERER Program. A background radiometer will be carried rather than an infrared missile detection payload. These flights will provide infrared background measurements for a wide variety of conditions, as may exist between arctic and tropical regions. They will assist in determining the magnitude of background radiance in the 2.7 and 4.3 micron absorption range and in establishing the spatial and spectral background characteristics which must be known for current as well as future MIDAS requirements.

The launches are scheduled for November and December.

b. The payloads for these flights are scheduled for delivery to Vandenberg Air Force Base in late September and October. The AGENA "B" vehicles will be available on approximately the same schedule. The launches are scheduled for November and December.

Re-ignition of the AGENA engine following initial shutdown has been proposed for the second flight.

c. It is proposed that the RM-2 flight include the first operational use of the AGENA vehicles restart capability. Although this would not be a full-scale dual-burn flight, the engine would be re-ignited following initial shutdown.

2. Technical Status

a. Second Stage Vehicles

Assembly of the AGENA "B" for the third MIDAS flight is on schedule.

(1) Assembly of the AGENA "B" vehicle for the third MIDAS flight is proceeding on schedule. The vehicle was delivered to the systems test area on 8 August. This will be the first MIDAS vehicle to utilize the full dual-burn capability of the AGENA engine.

Fourth MIDAS AGENA vehicle to be completed on 10 October.

(2) Assembly of the AGENA vehicle for the fourth MIDAS flight is scheduled for completion on 10 October. It is anticipated that assembly of this vehicle will be completed on schedule.

Solar auxiliary power array completes 1000 hours of continuous cycling.

(3) The electromechanical equipment for positioning the solar auxiliary power array has successfully completed approximately 1000 hours of continuous cycling.

b. Infrared Scanner Units

(Infrared scanned units for flights 3, 4, and 5 are being manufactured by Baird-Atomic, Inc., and for flights 6, 7 and 8 by Aerojet-General Corporation.)

Delivery of initial flight infrared scanner unit is scheduled for 6 October.

(1) Production and organizational changes directed toward achieving the desired production quality and delivery rate have been instituted at Baird-Atomic, Inc. A re-evaluation of their delivery schedule has established 6 October as the delivery date for the initial flight unit.

Ground readout units are programmed for delivery on 8 and 22 September.

(2) The delivery dates for the two Baird-Atomic, Inc., ground readout units have been established as 8 and 22 September. These schedule slippages, caused by delays during systems tests, will have no effect on flight schedules.

Aerojet is developing a service test model of an advanced infrared detection payload.

(3) Aerojet-General is developing a service test model of an advanced infrared detection payload for use on later MIDAS flights. A detailed reliability test program is being developed for this payload. In addition to developing the service test model of this payload, Aerojet is now contracted to procure long-leadtime items for the flight payloads. A definitive contract for this payload is expected to be completed in September.

3. Facilities

Facility design criteria for the East Atlantic station are scheduled for completion in October.

a. A government-to-government agreement is being drafted for the United Kingdom Readout Station in anticipation of approval of the MIDAS operational program. Facility design criteria for this station are scheduled for completion in October. Design will be initiated by the Third Air Force following receipt of criteria and approval to proceed from Headquarters, U. S. Air Force and U. S. Air Force (Europe).

Authorization was granted in August to proceed with establishment of the Southeast Africa station.

b. Responsibility for Southeast Africa Station site selection, construction, and operation was assigned to the Atlantic Missile Range in June. The design criteria were completed by Air Force Ballistic Missile Division and supplied to the Atlantic Missile Range, during August. Also during August, the Atlantic Missile Range siting team selected the location and authorization was granted to proceed with the establishment of this station. The station's primary function will be to record AGENA "B" second-burn performance data. A portable van installation will be used to support the February MIDAS flight.

Construction of the North Pacific station technical facilities is on schedule; support facilities are two months behind schedule.

c. Construction of the Donnelly Flats, Alaska, technical facilities is proceeding on schedule. Because of last year's prolonged steel strike and the late thaw this spring, construction of the support facilities at Fort Greely, Alaska, will be delayed approximately two months. Completion is now scheduled for December.

IV. TRANSIT PROJECT

(NAVIGATION SATELLITES)

A. Project Objective

Objectives - General

The objective of the TRANSIT Project is to provide an accurate and reliable means of fixing precisely the position of military surface craft, submarines, and possibly aircraft on an all-weather global basis, and of civil vehicles with somewhat reduced accuracy.

B. Project Description

General

TRANSIT Project developing a reliable, accurate system of navigation.

a. The TRANSIT Project consists of the design, development, and test of a system of navigation conceived by the Applied Physics Laboratory, The Johns Hopkins University, and based on the Doppler shift observed in radio signals from artificial earth satellites. The TRANSIT Project will provide a reliable means of fixing the position for surface craft, submarines, and aircraft anywhere in the world more precisely than has heretofore been possible, and will provide under any weather conditions more accurate means of maritime and aerial navigation than is now available.

System to be operational in 1962

b. The system will be operational in 1962. It will consist of (1) several satellites in orbit about the earth at altitudes optimum for accurate tracking, (2) a network of tracking stations supplying tracking data to a computing complex to maintain an accurate ephemeris of each satellite, (3) a means of supplying to each navigation station the ephermerides of the satellites as well as reference time standard signals, and (4) navigating equipment designed to receive the Doppler data from the satellite and to determine efficiently a navigational fix from these data.

C. Progress Review - June, July, August 1960

1. Flights

a. TRANSIT 1 B

The 1B was launched 13 April 1960. Excellent data have been obtained.

(1) Since TRANSIT 1B was launched 13 April 1960, excellent data on its orbits have been determined.

Day-by-day consistency in orbit determinations was achieved.

(2) The parameters of the TRANSIT 1B orbit were determined day by day, independently each day, on the basis of one day's doppler tracking data, using the Univac 1103 computer. The characteristics of the orbit over an interval of more than two months (20 April to 1 July) were graphically charted. The graphs show the day-by-day consistency of the orbit determinations. During this interval, 1 day = 15.04 satellite revolutions (mean, anomalistic).

1B orbit changed in size and shape indicating north-south asymmetry of the earth's gravitational field.

(3) From these curves, it is obvious that the orbit has changed in size and shape. The semimajor axis decreased with time because of drag. The eccentricity changed with the latitude of perigee. It increased during the first seven weeks and then decreased more rapidly than it has increased; i.e., the eccentricity decreased on the average, but was greater than expected when the perigee latitude was at its farthest north and less than expected when perigee was at its farthest south. This suggests an asymmetry of the earth's gravitational field in the two hemispheres. Since perigee and apogee are functions of the eccentricity, they obviously exhibit variations of a sinusoidal type along with a decreasing mean value. The variations shown in these curves may be related to higher order terms in the expression for the earth's gravitational field or to effects of the sun and moon, of air drag variations, etc. Work on analyzing these variations is in progress.

Close agreement between TRANSIT 1B orbits determined from Doppler data and from optical data.

(4) Table 1 shows that the orbit of the 1B satellite determined by The Johns Hopkins University, Applied Physics Laboratory, using doppler tracking data is in close agreement with the orbit determined by the Smithsonian Astrophysical Observatory using optical data.

TABLE 1

COMPARISON OF TRANSIT 1B ORBIT DETERMINED BY SMITHSONIAN ASTROPHYSICAL OBSERVATORY (SAO) FROM OPTICAL DATA AND BY APL/JHU FROM DOPPLER TRACKING DATA

	SAO	APL/JHU
Epoch 26 May	0 hr UT	0 hr UT
Semimajor axis	4308.6 st. mi.	4308.30 st. mi.
Eccentricity	.027765	.028016
Inclination	51.295°	51.272°
Argument of perigee	52.714°	53.105°
Right ascension of ascending node	79.690°	79.952°
Time of perigee	19 hr 13 min 47 sec	19 hr 13 min 58 sec
Precession of perigee	3.666 deg/day	3.444 deg/day
Precession of ascending node	-4.666 deg/day	-4.657 deg/day

Predictions of precise orbits 90 days ahead may be possible.

(5) The 1B orbital data are now being analyzed in developing procedures for predicting precise orbits as much as 90 days ahead. The results to date are excellent.

1B having difficulty transmitting signals.

(6) On 11 July, the 1B satellite began having difficulty transmitting signals. Strong indications are that the present undesirable operation of the 1B satellite is caused by a change due to ageing in the calibration of the thermal switch. When the thermal switch opened, the satellite was left in the "C" Mode of operation, thus depleting the batteries. Because of this behavior of the thermal switch the batteries could not recharge sufficiently to permit operation of the satellite in another mode.

b. TRANSIT 2 A

TRANSIT 2A was successfully launched 22 June 1960.

(1) The TRANSIT 2A satellite was successfully launched into orbit around the earth 22 June 1960 by a THOR-ABLE STAR vehicle at Cape Canaveral, Florida. Signals were received at all TRANSIT ground stations at the expected time after launch. The doppler data and telemetered data received indicate that the subsystems are functioning satisfactorily.

Separation of TRANSIT and pickaback satellite successful.

(2) The separation of the pickaback satellite, GREB, from TRANSIT at the time of injection was successfully accomplished.

Despin of satellite effected by magnetic despin device in satellite.

(3) Because the satellite was not injected into the desired orbit of 500 n. mi., and the injection angle of the satellite may not be within the specified tolerance, the magnetic rods in the satellite caused the spin rate to decrease faster than desired. This prevented the de-spin weights from deploying, although from telemetry it was determined that the de-spin actuation mechanism operated properly. However, de-spin of the satellite was effected by the magnetic rods at the end of July. There is a possibility that the No. 40 copper wires used for the Canadian experiment prevented the weights from deploying.

NOTS and Canadian equipment carried in the satellite operated satisfactorily.

(4) Although the Naval Ordnance Test Station (NOTS) infrared scanner and the Canadian galactic noise experiments were not part of the TRANSIT program, preliminary results indicate that these experiments were successful and useful data were obtained.

Excellent orbits have been determined.

(5) Excellent orbits for the 2A satellite have been determined. On 10 August, the orbit had a perigee of 388 statute miles and an apogee of 665 statute miles. Its inclination to the equator is 66.7 degrees, and the period is 101.6 minutes.

Satellite's mode of operation changed on command by signals from ground equipment.

(6) From the time of launch until the middle of August the command system of the satellite was operated almost daily from ground equipment located at the Applied Physics Laboratory, The Johns Hopkins University, to change the satellite's mode of operation and to switch the telemetry system on and off. The satellite has not been left in the mode of operation that includes the telemetry system.

c. TRANSIT 3A

TRANSIT 3A satellite will be similar to the 2A, but will include a data storage system. Launching scheduled for November 1960.

The mechanical mock-up of the internal structure and package arrangement of the 3A satellite have been completed. The satellite will include a memory system to permit the initial experiment with a satellite-born memory and a ground-based injection system. The memory system will be capable of storing 384 bits of digital information and to read out the contents at a rate of 92 bits a second once every 22 seconds.

d. TRANSIT-ON-DISCOVERER

TRANSIT-type oscillators were installed in DISCOVERER XIV, which was launched 18 August 1960.

Although DISCOVERER XIV was successfully launched, no signals from the TRANSIT equipment installed in the DISCOVERER were picked up. Because access to the vehicle for the usual prelaunch checkout was not permitted, it is not known whether the TRANSIT equipment was properly installed. The fact that the TRANSIT stations could not receive any signals from the TRANSIT transmitter indicates that the equipment was not operating properly.

2. Receiving Stations

The TRANSIT receiving stations have been successfully tracking TRANSIT 2A and 1B satellites.

a. The eight TRANSIT receiving stations have been tracking the TRANSIT 2A satellite since time of launch 22 June 1960 as scheduled. The stations also continued to track TRANSIT 1B. After the 2A launching, two stations tracked the 1B satellite full time; the other stations tracked it on an abbreviated basis. At the end of August, only two stations were listening for the 1B signals; all other stations have ceased tracking the satellite. All stations tried to track TRANSIT-On-DISCOVERER when DISCOVERER XIV was launched 18 August 1960 but no TRANSIT signals were heard. It is not known whether the TRANSIT equipment was operating satisfactorily prior to launch or whether it was properly installed, since access to the vehicle for the usual prelaunch checkout was not permitted.

b. Seven of the stations are now equipped to receive 54 and 324 mc signals from the satellite's "C" system, as well as 162 and 216 mc signals from the satellite's "B" system. Preprototype refraction-correction units are now in use at

Station 01 at the Applied Physics Laboratory of The Johns Hopkins University and Station 02 at Austin, Texas. The units work well with data from both the "B" and "C" systems. Other stations will soon be supplied with similar units.

NOTUS

V. NOTUS PROJECT

(COMMUNICATIONS SATELLITES)

A. Project Objective

1. General

NOTUS objective is to establish a global military communications system.

a. The objective of the NOTUS Project is to obtain at the earliest practicable date a family of satellite-borne communications repeaters, which will provide a global military communications system. This system will be capable of meeting military requirements for long range radio communication links of high reliability, security, and large capacity under conditions of natural or man-made interference.

The NOTUS Project consists of two parts -- COURIER and ADVENT.

b. The NOTUS Project is a dual research and development program aimed at demonstrating the feasibility of placing communications satellites into useful orbits and being able to communicate between distant points on the earth's surface by means of satellite repeaters for extended periods of time both on a delayed time and a real-time basis. These two parts of the NOTUS Project are known as (1) COURIER, a delayed repeater satellite project and (2) ADVENT, a real-time repeater satellite project.

2. Delayed Repeater Communications Satellite - COURIER

Initial phase of NOTUS is the delayed repeater satellite, COURIER.

The initial phase of the NOTUS Project is the development of an orbiting delayed repeater communications satellite (COURIER) that will receive and store messages from one ground station and transmit and deliver the messages to another ground station at a later time and place in its orbit.

3. Instantaneous Repeater Communications Satellite - ADVENT

Second phase of NOTUS is the instantaneous repeater satellite, ADVENT.

The second phase of the NOTUS Project is the development of a real-time repeater communications satellite, ADVENT, located in a 24-hour synchronous (hovering) equatorial orbit, that will provide instantaneous point-to-point communications between any

number of transmitting and receiving stations within the line-of-sight beam from the satellite. Three such satellites equally spaced about the equator would provide instantaneous communications service between any number of surface stations wherever located on earth except for the polar regions.

B. COURIER Project

1. Project Objectives

Objective is to develop a delayed repeater satellite communications system.

The basic objective of the COURIER Project is to determine the feasibility of developing a delayed repeater communications system based upon an orbiting satellite.

2. Project Description

COURIER Project comprises two launchings

The COURIER delayed repeater communications satellite project comprises two launchings into circular orbits of 650 nautical miles altitude and inclined 28.3 degrees to the equator. These two launchings and resultant tests are the first phase of the NOTUS Project to demonstrate the feasibility of active communications satellites to play an effective role as part of a world-wide military communications network.

3. Progress Review - June, July, August 1960

a. General

First COURIER launching unsuccessful; another scheduled October 4, 1960.

The launching of the COURIER 1A satellite on August 18, 1960, was unsuccessful. COURIER 1B is scheduled to be launched on October 4, 1960.

b. Schedule

COURIER launch dates delayed one month.

The Zanzibar government situation required the relocation of the mobile tracking station to Southern Rodesia during July. Also, technical problems were found in the EPSILON second-stage vehicle. This necessitated certain vehicle configuration changes. These two factors required rescheduling the launches of COURIER 1A and 1B from July 19 and September 1 to August 18 and October 4, 1960, respectively.

c. Satellites

Booster malfunction caused failure of COURIER 1A.

(1) The COURIER 1A satellite was launched from Cape Canaveral on August 18, 1960. The vehicle proceeded to a height of approximately 15 miles, but a malfunction of the THOR booster resulted in an explosion. The components of the booster vehicle and the satellite fell into the Atlantic Ocean approximately 2-1/2 minutes after launch.

COURIER 1B being readied for launch.

(2) COURIER 1B satellite is undergoing pre-launch tests and checkout in preparation for the final COURIER launch attempt on October 4, 1960.

d. Ground Stations

Both ground stations are being maintained in standby condition.

Fort Monmouth and Puerto Rico stations are in a standby condition until COURIER 1B is launched. Ground crews are following daily checkout procedures, tracking and alignment to maintain the stations at optimum performance. In addition, contractor personnel are re-aligning, repairing and checking the checkout van which was damaged by hurricane winds at Cape Canaveral.

e. Project Management

COURIER Project transferred from ARPA to Army.

(On September 15, 1960, the over-all technical and management responsibility for the COURIER Project was transferred from the Advanced Research Projects Agency to the Department of the Army in accordance with Department of Defense satellite mission assignments).

C. ADVENT Project

1. Project Objective

General

Objective is to develop an instantaneous repeater satellite communications system.

The basic objective of the ADVENT Project is to demonstrate the feasibility of developing a real-time high channel capacity global (excluding the polar regions) surface-to-surface communications capability by means of a satellite repeater. In operational configuration, three such satellites

equally spaced about the equator would be instantaneously available for communications between any number of surface stations wherever located on the earth, except for the polar regions above and below 80 degrees North and South latitudes.

2. Project Description

General

ADVENT to be developed in two phases.

(1) The ADVENT Project is particularly oriented toward meeting the generalized requirements of the three military services to augment their present long haul point-to-point high precedence traffic networks. Because of its complexity, the rigid tolerances that its several subsystems must meet, the extreme altitude of its orbit and the current non-availability of a reliable ATLAS-CENTAUR booster required to place its approximately 1200-pound payload into the 24-hour orbit, ADVENT will be undertaken in two phases.

Phase I comprises three ATLAS-AGENA "B" firings into low altitude orbits.

(2) Phase I of ADVENT will involve three ATLAS-AGENA "B" firings from the Atlantic Missile Range into orbits of relatively low altitude - 5000 nautical miles - inclined 34.2 degrees to the equator. These firings are scheduled for December 1961, March 1962, and June 1962. The purpose of these launchings will be to test the soundness of the satellite design configuration and the ability of the satellite subsystems to stabilize the satellite in attitude and to control the orientation of the solar cells. Pending the availability of satellite and ground station communications subsystems, these launchings will also be devoted to testing power storage devices and preliminary microwave communications system designs or major components thereof in actual space environment.

Phase II comprises seven ATLAS-CENTAUR firings into high altitude orbits.

(3) Phase II of ADVENT will be devoted to completing the development of a real-time microwave communications satellite repeater and placing it into a 24-hour synchronous (hovering) equatorial orbit of 19,300 nautical miles altitude. Seven ATLAS-CENTAUR launchings from the Atlantic Missile Range will be used for this purpose. The system should be capable of providing point-to-point communications in full duplex operation with long-life, reliable components, anti-jamming protection, and some

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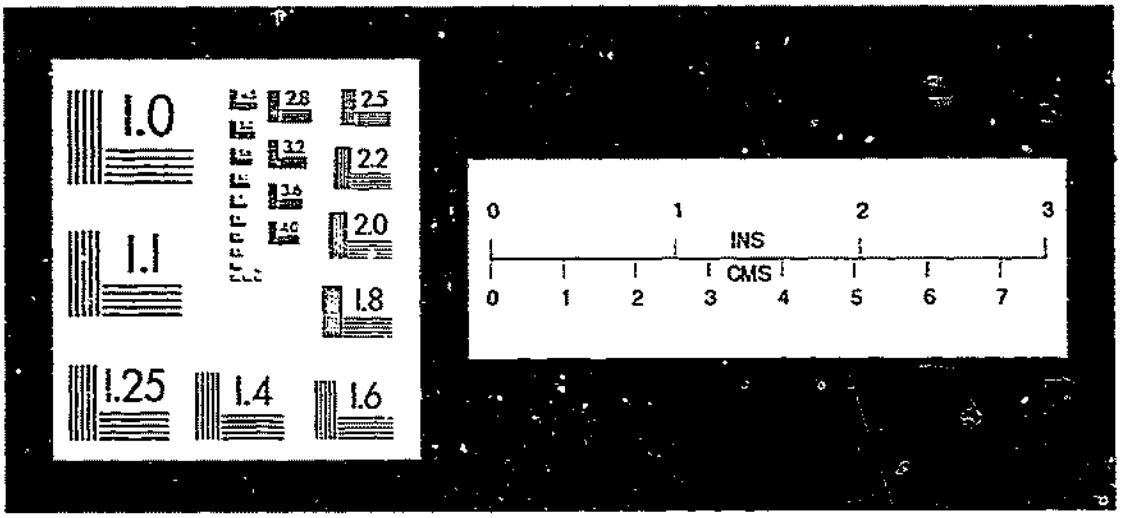

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adaptation of crypto security techniques. It is the purpose of Phase II to provide a basic technology for future systems and to provide logical development steps towards larger payload systems for future military requirements.

3. Progress Review - June, July, August 1960

a. General

ADVENT Project scope defined.

During the reporting period, the technical scope of the ADVENT Project was defined as a five-year research and development program estimated to cost $174,000,000. Ten launches are programmed from the Atlantic Missile Range in accordance with the following schedule:

Launch Date	Booster	Second Stage	Vehicle Funded By
March 1962	ATLAS	AGENA "B"	DOD
June 1962	ATLAS	AGENA "B"	DOD
September 1962	ATLAS	AGENA "B"	DOD
December 1962	ATLAS	CENTAUR	NASA
February 1963	ATLAS	CENTAUR	NASA
March 1963	ATLAS	CENTAUR	DOD
May 1963	ATLAS	CENTAUR	DOD
July 1963	ATLAS	CENTAUR	DOD
September 1963	ATLAS	CENTAUR	DOD
November 1963	ATLAS	CENTAUR	DOD

b. Final-Stage Vehicle

Final-Stage Vehicle contract negotiation scheduled.

(1) Contract negotiations are scheduled to begin in late September for the final-stage vehicle.

Studies of various FSV technical requirements are continuing.

(2) Investigations of attitude and orbit control requirements of the final-stage vehicle are continuing. An earth and sun acquisition proposal, utilizing the sun as an initial reference, has been defined. Temperature control requirements prior to injection into a circular orbit have been studied.

c. Microwave Communications Equipment

Contracts have been awarded for the satellite and ground station microwave communication and tracking equipment.

Contracts for the development, fabrication, and installation of the 60-foot automatic tracking antenna system for the ground station equipment, and for the development, fabrication, installation and test of the microwave communication equipment for the satellite and the ground stations have been awarded. A contract is being negotiated for development of a high power, X-band Klystron tube prototype for use in the ground station equipment. Studies to verify satellite microwave communication equipment continued.

d. Launching Vehicles

The performance specifications are being revised.

Performance specifications recommended for use in procurement of ATLAS and CENTAUR vehicles and the CENTAUR engines are being revised to utilize performance figures contained in the latest NASA specifications for the development of the CENTAUR engine.

e. Tracking, Telemetry, and Command Equipment.

Contract awarded for the preliminary design of tracking, telemetry, and command equipment.

The Atlantic Missile Range is developing requirements for ground command and tracking equipment. A contract has been awarded for the completion of preliminary design and specification data to meet the satellite tracking, telemetry and command equipment requirements.

f. Ground Stations

Preliminary selection of ADVENT ground station has been made.

Surveys have been conducted on both East and West coasts of the United States to locate suitable sites for ADVENT ground stations. Aerial and ground surveys of both regions resulted in the preliminary selection of Fort Dix, New Jersey and Camp Roberts, California.

g. Project Management

ADVENT Project transferred from ARPA to Army.

(On September 15, 1960, the over-all technical and management responsibility for the ADVENT Project was transferred from the Advanced Research Projects Agency to the Department of the Army in accordance with Department of Defense satellite mission assignments).

SHEPHERD

VI. SHEPHERD PROJECT

(TRACKING NETWORK)

A. Project Objective

Project Objectives - Establishment of a space surveillance system to detect and identify space objects.

The objective of the SHEPHERD Tracking Network Project is the establishment of a space vehicle surveillance system that will detect and identify space objects both foreign and domestic. The system must also have the capability for orbit determination and prediction of future position of space objects and maintain a catalog of this information for users in the intelligence and defense fields.

B. Project Description

1. General

SHEPHERD comprises sensor elements and a control center.

a. The initial system developed for the Advanced Research Projects Agency (ARPA) comprises sensor elements for detecting nonradiating objects in near outer space and a data collection and satellite cataloging center. The principal sensor of the system is the space surveillance (SPASUR) detection fence developed by the Navy. This is located on an east-west line at about 32 degrees latitude in the United States. This fence presently comprises two complexes, one in the east and one in the west each with coverage of 400 miles in altitude and 300 miles in width. Each complex consists of a centrally located transmitter station and two remote receiver stations along the east-west line.

Two surveillance areas exist at present.

DOPLOC project terminated.

b. The gap between the present two complexes was to have been filled by a DOPLOC system, based on the Doppler shift observed in radio signals from artificial earth satellites, a different technical approach from the SPASUR system. The DOPLOC project has been terminated as a result of a determination that it would not meet the immediate objectives of the program as early as the SPASUR system.

A 500 KW transmitter will fill the present detection gap.

c. A centrally located 500 KW transmitter has been authorized that will fill the detection gap between the present two complexes and provide space surveillance coverage over an area 1,500 miles in

altitude and 2,000 miles in width. This will assure a high probability of detection of any satellite within that area on its first pass over the United States.

2. Other Sensor Data

Sensor data are provided by sources other than SPASUR.

Sensor data relating to space objects are provided from other sources, such as the National Aeronautics and Space Administration (NASA) tracking stations, the Army, Navy, and Air Force missile ranges and radar sites, such as the Ballistic Missile Early Warning System (BMEWS) and research and development centers.

3. National Space Surveillance Control Center

Control Center processes data, computes orbits, catalogs and issues position prediction of all space objects.

Information from the SPASUR system and all other sources is transmitted to the Air Force developed Interim National Space Surveillance Control Center (SPACETRACK) located at Bedford, Massachusetts. This center collates the data received, computes space vehicle orbits, catalogs the space vehicles and issues orbital position predictions. This development has resulted in the recommendation for completion of a permanent National Space Surveillance Control Center.

4. Development of Improved Tracking Antennas

Development of improved tracking antennas.

A Department of Defense contribution to electronic subsystems development has resulted in the construction of two 40-foot tracking antennas. These are in the final stages of construction with delivery scheduled for this fall.

5. Operational and Management Responsibility

Assignment of responsibility is under study.

A study is being made by the Department of Defense as to the appropriate assignment of operational and management responsibility to the military services for (1) the ARPA developed satellite detection fence (SPASUR) and (2) the National Space Surveillance Control Center (SPACETRACK).

C. Progress Review - June, July, August 1960

1. SPASUR

Improvements in SPASUR underway.

The contract for the 500-kw central transmitter is under negotiation. Proposals for associated transmitter antenna are being evaluated. Work continued on the automatic digital data processing and alert system for all receiving stations. All work will be completed by spring 1961.

2. SPACETRACK

Advanced Research on SPACETRACK completed.

A "Conceptual Design Plan for the National Space Surveillance Control Center" has been completed and is under evaluation. This plan completes the advanced research effort for SPACETRACK.

3. 40-foot Antennas

40-foot antennas transferred for other use.

As a result of changes in the Department of Defense and NASA programs, the 40-foot tracking antennas under development by ARPA were considered to be of greater use for intelligence purposes than for the United States space program. In June, the two antennas were transferred for use by the intelligence community.

4. Operations and Management

JCS study assignment of SPASUR and SPACETRACK.

The Joint Chiefs of Staff continued their study of operational and management assignment to one of the military services for SPASUR and SPACETRACK. A decision is anticipated in September.

FUNDS

VII. STATUS OF FUNDS BY PROJECTS

(In Millions of Dollars)

31 August 1960

Project	Funding FY 1960 and Prior Years	Amounts Programmed FY 1961	Cumulative Obligations	Cumulative Expenditures
DISCOVERER 1/ (R&D Satellites)	$ 221.7	$ 55.1	$ 225.2	$ 205.1
MIDAS 1/ (Early Warning Satellites)	81.4	119.6	98.7	56.7
TRANSIT (Navigation Satellites)	34.0	21.6	23.3	19.9
NOTUS (COURIER/ADVENT) (Communications Satellites)	42.3	3.0	41.4	22.6
SHEPHERD (Tracking Network)	42.5	0	39.6	24.6

1/ Excludes $97.0 million programmed during FY 1958 and prior years for WS 117L program. DISCOVERER, SAMOS, and MIDAS projects are outgrowths of WS 117L.